MULTIMEDIA UNIVERSITY®

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 1, 2016/2017

EMF2016 ELECTROMAGNETIC THEORY

(All Sections / Groups)

15 OCT 2016
09:00 A.M – 11:00 A.M.
(2 Hours)

INSTRUCTIONS TO STUDENTS

1. This question paper consists of 7 pages including this cover page with 4 questions only. Common constants for air are listed on Page 5.

2. Attempt all four questions. All questions carry equal marks and the distribution of marks for each question is given.

3. Please print all your answers in the answer booklet provided.

4. Please tie and submit worked Smith charts together with the answer booklet.

Question 1

(a) A 1 GHz source is connected to a load Z_L with impedance $(60 + j60)\,\Omega$ via a 1-m 50 Ω lossless air-filled coaxial cable. Without using Smith chart, compute the following parameters.

(i) The phase constant.

[3 marks]

(ii) The reflection coefficient at the load

[4 marks]

(iii) The input impedance of the cable at the source end.

[5 marks]

(b) A 50 Ω lossless transmission line is terminated with an unknown load. The measured standing wave ratio (SWR) is 2.6. The distance between successive voltage minima is 25 cm, and the first minimum is located at 8 cm from the load. Using Smith charts (provided at the end of this question paper), determine the load impedance.

[13 marks]

(**You need to submit the worked Smith charts.** Write all markings and labels clearly. Detach them from the question paper and tie them to your answer booklet.)

Continued ...

Question 2

(a) Write down the four Maxwell equations in differential form and the physical laws they represent.

[8 marks]

(b) With a magnetic field $\underline{\mathbf{B}} = \hat{\mathbf{z}}\cos(\omega t)$ (mWb/m^2), a conducting sliding bar oscillates over two parallel conducting rails as shown in Fig. Q2.1. The rails are terminated in a resistance, R. The position of the sliding bar is given by $x = 0.15(1-\cos(\omega t))$ (m). Note that the two ω are the same. Determine the magnetic flux linking the loop formed by the sliding bar, the rails, and the resistor R.

[7 marks]

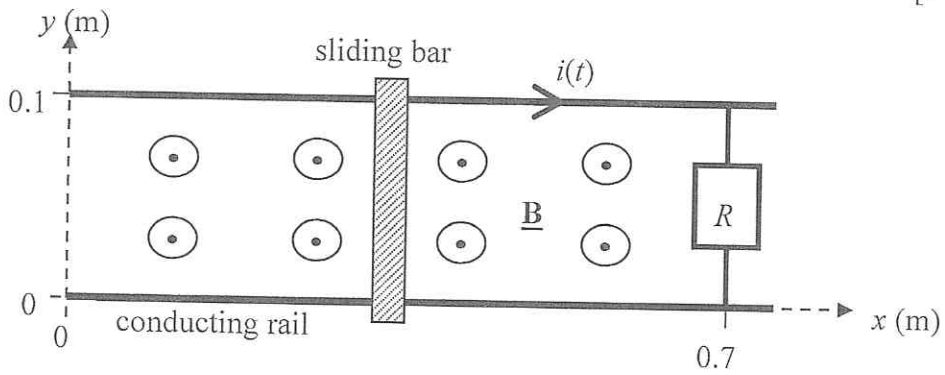

Fig. Q2.1

(c) For the circuit given in Fig. Q2.2, find the electromotive force V_{emf} developed across terminals 1 and 2 and the current I flowing through the resistor R. The rectangular circuit loop has a constant width l, but its length x increases with time as a conducting bar slides at a constant velocity $\underline{\mathbf{u}}$ in a static magnetic field $\underline{\mathbf{B}} = \hat{\mathbf{z}}\,2B_0\,x$. Note that $\underline{\mathbf{B}}$ increases linearly with x. The bar starts from $x = 0$ at $t = 0$. Use the polarity of voltage and current as defined in Fig. Q2.2. Assume that the loop resistance is negligible compared to R.

[10 Marks]

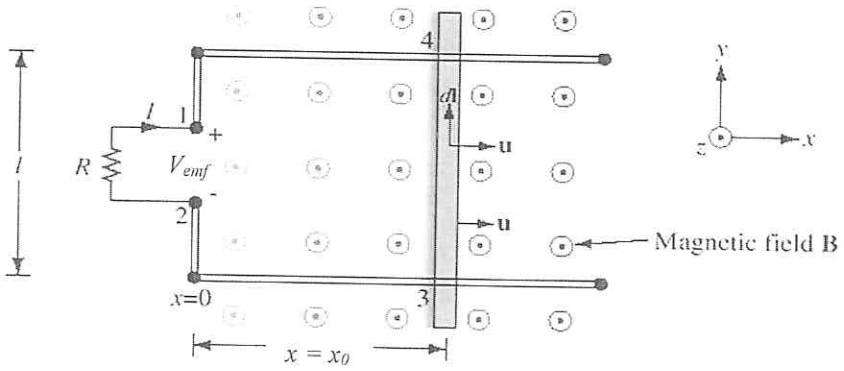

Fig. Q2.2

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Question 3

(a) The magnetic field of a plane wave propagating in a nonmagnetic medium is given by

$$\underline{\mathbf{H}} = \left[\hat{\mathbf{x}}30\cos\left(\pi\times10^{8}t-0.4\pi z\right)+\hat{\mathbf{y}}40\cos\left(\pi\times10^{8}t-0.4\pi z\right)\right](mA/m).$$

Determine the following:

(i) The phase velocity. [2 marks]

(ii) The wavelength. [2 marks]

(iii) The relative permittivity of the medium, ε_r. [3 marks]

(iv) The electric field, $\underline{\mathbf{E}}$ [6 marks]

(b) A 45-MHz plane wave in air (medium 1) impinges at normal incidence on a flat surface of a lossless non-magnetic dielectric medium (medium 2) with $\varepsilon_r = 42$. The electric field intensity of the incident plane wave in air is 55 V/m. Determine the following:

(i) The reflection coefficient. [4 marks]

(ii) The average power densities of the incident and reflected waves. [6 marks]

(iii) The standing wave ratio. [2 marks]

Continued ...

Question 4

(a) List **three** advantages of optical fiber over coaxial cable.

[3 marks]

(b) Find the dominant resonant frequency for an air-filled rectangular cavity of size $3\times6\times6$ cm^3.

[4 marks]

(c) An air-filled waveguide has dimensions 8 cm × 10 cm. Calculate the dominant mode **cutoff frequency** and **waveguide wavelength** at 3 GHz.

[7 marks]

(d) A dielectric slab with a refractive index of 3.00 and thickness of 100 mm is suspended in air.

(i) What is the relative permittivity of the dielectric?

[2 marks]

(ii) At what angle from a normal to the dielectric-air boundary will light be contained (totally reflected) within the dielectric?

[3 marks]

(iii) Calculate the maximum frequency at which the dielectric slab will support only one mode.

[6 marks]

Common constants for air

Speed of light, c =	3×10^8 m/s
Permittivity, ε_0 =	8.854×10^{-12} F/m
Permeability, μ_0 =	$4\pi \times 10^{-7}$ H/m
Intrinsic impedance, η_0 =	377 Ω

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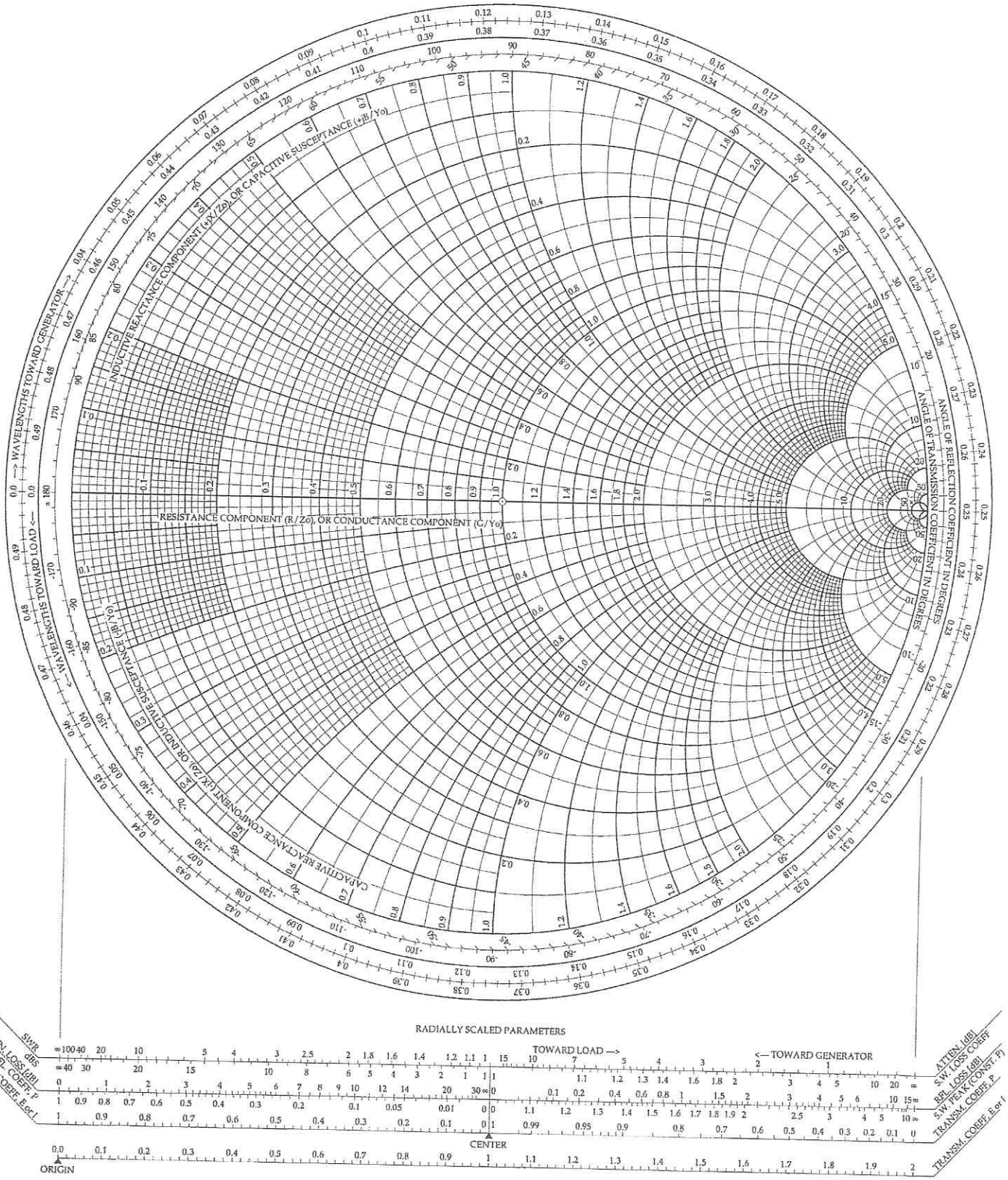
The Complete Smith Chart

Black Magic Design



http://www.sss-mag.com/pdf/smithchart.pdf

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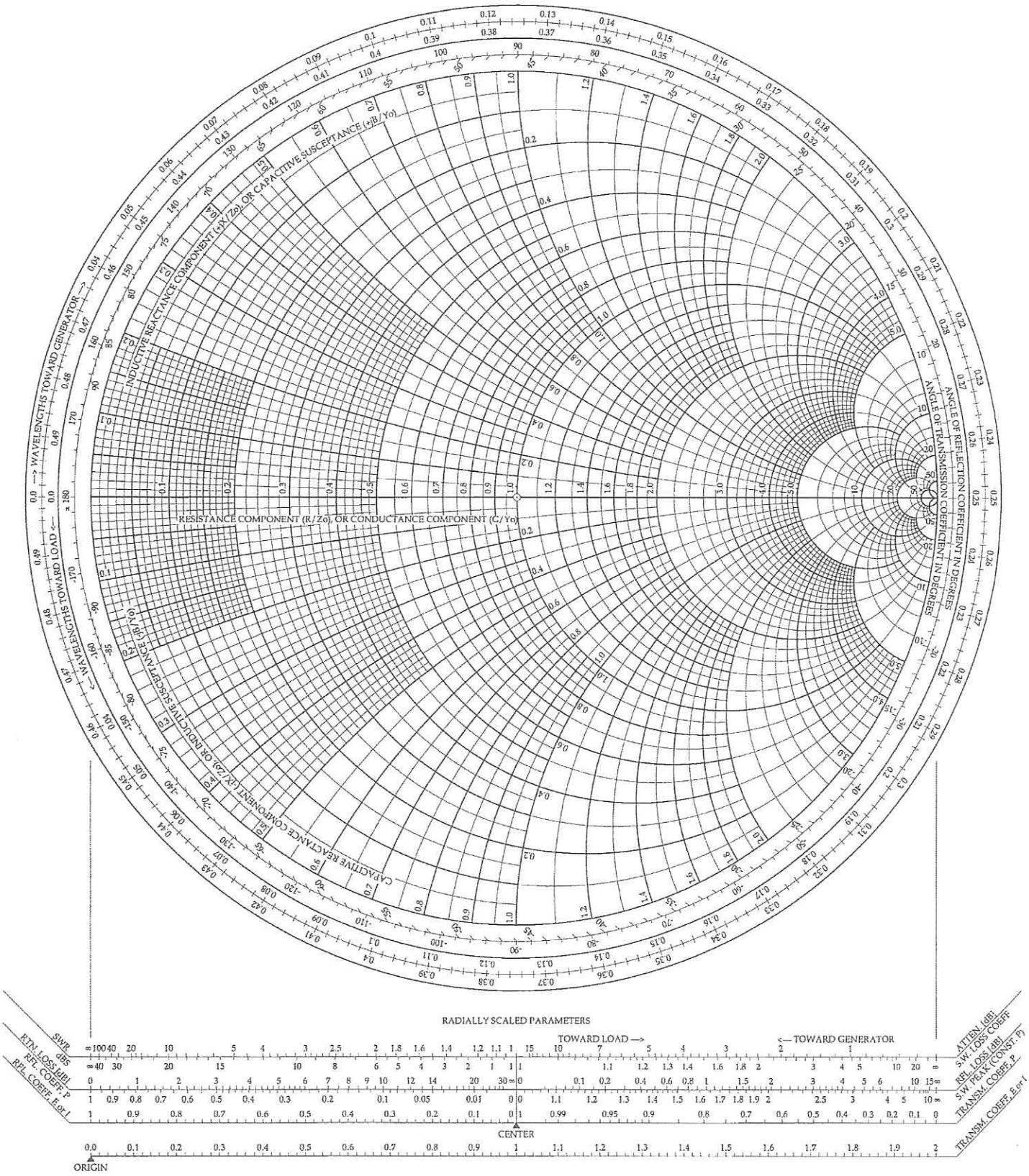
The Complete Smith Chart

Black Magic Design


RESISTANCE COMPONENT (R / Zo), OR CONDUCTANCE COMPONENT (G / Yo)
INDUCTIVE REACTANCE COMPONENT (+jX / Zo), OR CAPACITIVE SUSCEPTANCE (+jB / Yo)
CAPACITIVE REACTANCE COMPONENT (-jX / Zo), OR INDUCTIVE SUSCEPTANCE (-jB / Yo)
ANGLE OF REFLECTION COEFFICIENT IN DEGREES
ANGLE OF TRANSMISSION COEFFICIENT IN DEGREES
--> WAVELENGTHS TOWARD GENERATOR -->
<-- WAVELENGTHS TOWARD LOAD <--
RADIALLY SCALED PARAMETERS
TOWARD LOAD -->
<-- TOWARD GENERATOR
SWR
RTN. LOSS (dB)
RFL. COEFF. P
RFL. COEFF. E or I
ATTEN. (dB)
S.W. LOSS COEFF
RFL. LOSS (dB)
S.W. PEAK (CONST. P)
TRANSM. COEFF. P
TRANSM. COEFF. E or I
CENTER
ORIGIN

http://www.sss-mag.com/pdf/smithchart.pdf

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